A REPORT

ON

SUPPLYING THE CITY OF OSWEGO

WITH WATER,

MADE TO THE MAYOR AND COMMON COUNCIL

BY

WM. J. McALPINE,

Civil Engineer,

SEPTEMBER, 1866.

OSWEGO:
C. MORRISON & CO., PRINTERS.
1866.

REPORT.

An abundant supply of pure and wholesome water is necessary to the health, comfort and prosperity of a city, and the superior economy, quality and convenience of a public water supply are now so generally appreciated, that there are but few of our Northern American cities, or even villages, but what are supplied in this manner.

The advantages of a public water supply are—

1. That it furnishes a better quality of water than can be obtained by any except a few of the most wealthy citizens, and then only in peculiar and unusual cases.

2. That the quantity supplied is so much greater and so readily accessible, that it encourages the free use of water among the poor as well as the rich, and consequently diminishes one large class of diseases, and in this aspect alone saves to the community a sum frequently equal to the interest on the whole cost of the works.

3. It furnishes an abundant supply of water at all times for the extinguishment of fires, so convenient and accessible that, in most cases, the household can put out the small beginnings of a fire which, in a short time, would defy the efforts of the whole fire department. Almost every city and village in our land has been visited with one or more of those extensive conflagrations, which have destroyed more property than the cost of water works constructed on the most liberal scale. It is true that large conflagrations sometimes occur in places supplied with water, but it is self evident that the liability to such disasters is much lessened by having on hand an abundant supply of water. From these considerations it will be apparent that the rates of insurance on property against losses by fire will be materially lessened, and thus, indirectly, contribute largely towards the repayment of the cost of the work.

4. The charges for the use of water are less than the aggregate cost of the same quantity obtained by individuals from wells and cisterns. There can be no question, therefore, but that a public supply is the most economical method of furnishing water to a compactly located population.

5. An ample supply of pure water encourages settlements and investments, and is indispensable for certain kinds of manufactories, while the absence of such a supply will probably divert more business from the city than the cost of the works.

The city of Oswego presents unusual facilities for procuring a bountiful supply of the purest water, and it is remarkable that with the experience of the past losses and the decision of other places, larger and smaller, that the determination of this question has been so long delayed.

The universal experience of other places has been that when a feasible project for introducing a water supply has been once started it sooner or later prevails, and when such plans have been carried out and the benefits practically demonstrated it has answered all of the previous objections and secured for it universal approbation.

The previous examinations of the subject have settled the source of the supply to a question between Lake Ontario and the Oswego river, and the present discussion will, therefore, be confined to these two sources.

Both of these plans require the use of mechanical power to elevate the water—the former by steam and the latter by water power.

The plans proposed will now be more particularly described, viz.:

1. THE LAKE PLAN.

A well will be sunk near the shore of Lake Ontario into which the water will be conducted by a pipe leading out into deep water. In this well will be placed pumps, to be driven by a steam engine, and the water forced through iron pipes to a reservoir located on the highest ground in the west divi-

sion of the city and a branch main leading to a similar reservoir in the east division.

From these two reservoirs a system of iron pipes will be laid, which will distribute the water to all parts of the city.

For reasons which will be mentioned hereafter, the pump well will be placed either at the foot of eighth street, on the west side of the harbor, or at Sheldon's point.

To obtain sufficiently pure water it will be necessary to extend the inlet pipe about six hundred feet from the shore, where the water will be about fifteen feet deep, so that the supply may be taken from about three feet above the bed of the lake, to escape the drift of sand and gravel in storms, and twelve feet below the surface to assure an equable temperature and escape floating matter.

The inlet pipe proposed is four feet in diameter, made of wrought iron, and must be protected by a very strong pier of wood filled with stone. A well chamber, provided with gates and screens, will be placed at the outer extremity of the inlet pipe.

This pipe will discharge by a syphon end into the pump well, which will be sunk to a depth of twelve feet below the level of the surface of the water in the lake. The upper portion of the well will be built up of masonry to form a foundation for the engine and pumps.

The steam engine will be one hundred and twenty-five horse power, if located at the foot of eighth street, and twenty more horse power if located at Sheldon's point. There will be two plunger pumps, each of fourteen inches diameter.

The main engine will be condensing, and there will be provided a duplicate non-condensing engine and pumps of two-thirds of the above power.

The condensing engine will furnish the present supply by running sixteen hours each day, and the duplicate non-condensing engine will furnish the same supply by running the whole twenty-four hours. As the latter will only be used at rare intervals, the economy of its first cost, rather than that of running, has been considered.

Several different plans of pumping engines might be presented for discussion, but for reasons hereafter stated the estimates have been based upon one kind in general use.

The pump main to the point where it branches to the two reservoirs will be twelve inches in diameter, and the two branches each ten inches. A large air chamber and check valve will be placed in the main near the pumps, another at the river crossing, and another in each of the branch mains at half the elevation to the reservoir.

The reservoir on the east side of the river will be twenty feet lower than that on the west side, but the friction of the water through the increased length of the main to the former will generally be about equal to this difference in the elevation of the two reservoirs, so that they will fill at about the same depth while the pumps are in operation, but when they stop it will be necessary to close the cock at the river to prevent the water from the west reservoir being all drawn off into the pipes and reservoir on the east side.

The pumping main to the east division may be carried across the river either at Bridge or Utica streets. In the former it would be necessary to use an inverted syphon at the draw and carry the pipe under the bridge in a box of six feet square, filled with charcoal to prevent the water from freezing in the winter. This box and the pipe, however, may be made nearly self-sustaining, so as to bring but little weight upon the trusses of the river bridge.

The pump main can be carried across the river on the Utica street bridge at less expense, and in like manner boxed and made self-sustaining. In either case stop cocks would be required in the mains on each side of the river to provide against accidents.

The reservoirs and distribution will be substantially the same in all of the plans, and will be more particularly described under those heads.

The common opinion is that the river water, after it enters the lake, invariably flows to the eastward, or off shore, and

never to the westward, and, therefore, that the supply should be taken from the lake west of the river mouth.

The direction of the river water, after it enters the lake, can be but slightly affected by the current which flows towards its discharge. The sectional area of the lake at this place is a thousand times greater than that of the St. Lawrence at the outlet of the lake, and, therefore, the average velocity of the water at the former, compared to the latter, would be only as one to a thousand, an effect which would be more than equalized by the faintest summer breeze from the east. The surface and shore currents of the lake are governed by the winds.

The meteorological records which are kept at a great many places on both shores of Lake Ontario, give the number of days in each year that the wind blows from each direction. The average resultant direction for many years has been from a little south of west, and therefore the general current of the surface of the lake must be in this direction, though, when the winds from other directions prevail for several days continuously, the lake currents are changed accordingly.

The resultant direction of the wind for the average of a number of years at several places along the shore of Lake Ontario is as follows:

At Buffalo,	Erie County,	S. 45° W.
" Lewiston,	Niagara County,	S. 52° 27' W.
" Millville,	Orleans County,	S. 74° 18' W.
" Gaines,	do.	N. 71° W.
" Rochester,	Monroe County,	N. 81° 58' W.
" Monroe,	do.	S. 53° 48' W.
" Palmyra,	Wayne County,	S. 69° 10' W.
" Mexico,	Oswego County,	S. 72° 8' W.
" Ellisburg,	Jefferson County,	S. 59° 12' W.
" Ogdensburgh,	St. Lawrence County	S. 69° 18' W.
" Goveneur,	do. do.	S. 80° 30' W.
" Potsdam,	do. do.	S. 66° 15' W.

The Academy at Mexico is the nearest station the records

of which are just now accessible, and they are sufficiently applicable to illustrate the subject under consideration.

TABLE.

	WINTER	SPRING.	SUMMER	AUTUMN	YEAR.
From the Northeast,	2.37	2.22	1.91	3.05	9.55
" " East,	5.53	5.23	2.63	4.85	18.24
" " Southeast,	18.86	15.61	11.08	13.00	58.55
Total,	26.76	23.06	15.62	20.90	86.34
Per cent.,	30.	25.	17.	23.	25.
From the Southwest,	6.62	6.27	10.82	10.55	34.26
" " West,	22.74	29.28	33.01	31.23	116.26
" " Northwest,	14.54	18.31	13.64	10.96	40.97
Total,	43.90	53.86	57.47	52.74	191.49
Per cent.,	48.8	60.	63.	58.	55.
From the North,	8.81	5.27	5.27	5.54	24.89
" " South,	10.76	8.81	13.64	11.82	45.03
Total,	19.57	14.08	18.91	17.36	69.92
Per cent.,	21.2	15.	20.	19.	20.
Grand Total,	89.33	92.00	91.98	91.00	347.75

It appears, therefore, that the winds blow from the westward a little more than half of the time, and from the eastward one-fourth of the time for the whole year, but in the winter months for nearly one-third of the time.

The river water, in flowing through the city, becomes contaminated by the sewerage matter, offal from the vessels in port and the refuse from the manufactories; the heavier portions of this matter will sink in the harbor or in the broad expanse of the lake, but the lighter portions will be carried to some distance by the current, and at some seasons will so seriously injure the water at the mouth of the inlet pipe that it will be necsssary to depend upon a supply from the reservoirs until the winds change the direction of the current.

The first place selected for the location of the pumps was at the foot of eighth street, but the above considerations seem to render it necessary to remove them further to the westward, and Sheldon's point was afterwards selected for the location.

This will involve the cost of an increased power to the engines to overcome the friction of three thousand four hundred feet more of pump main, besides the increased cost of this main.

The most serious difficulty connected with the lake plan will be in the building of suitable piers in the lake to protect the inlet pipe.

The shore and bed of the lake is a smooth sandstone rock, over which the waves are driven in gales with but little friction, and acquire a force which the strongest work will hardly resist, while the same smooth surface renders it difficult to secure the piers at the bottom (as could be done in sand), and therefore the piers must be made of great size, as well as strength, so as to oppose their own insistent weight to the force of the waves.

These difficulties have been illustrated in the construction and maintainance of the harbor piers, and show that works of this character at the place in question must be made equally strong, and even then will be liable to constant derangement.

These protecting piers can only be placed in the lake when it is calm, and the uncertainty of such times and of their duration will increase the cost of this portion of the work.

In view of all these difficulties, I think it would be advisable to make a trial by boring into the rock on the shore to a considerable depth, to ascertain whether the strata of the rock, at the required depth, are sufficiently open to allow the lake water to flow into a well in sufficient quantities to furnish the supply desired.

The sand rock lies in thin, nearly horizontal, strata, and, above the water, appears to be open enough to allow sufficient water to flow through. If the trial holes should indicate a successful result, a large well should be sunk near the site of the proposed pump house to such a depth as would intersect enough of these open strata to yield the required supply. While sinking this well the fissures in the rock should be closed up as they are encountered, so as to dimin-

ish the expense of the temporary pumping while the excavation of the well is in progress, and when it is complete the fissures on the side of the well towards the lake should be opened.

The cost of this work is conjectural, but it is evident that it would be very much less than that of the supply pipe and its protecting piers.

2. THE RIVER PLANS.

The water required for the use of the city, and also the power necessary to elevate it, will be taken from the Oswego River, either from one of the hydraulic canals at the lower dam or from the pond at the upper dam, and by means of water wheels pumps will be driven which will force the water through iron pipes to two reservoirs, placed one on each side of the river, and from thence distributed by two independent system of iron pipes to every part of each of the grand divisions of the city.

The two river plans are alike in their general features, and will be described together, noting where they differ.

A wheel-pit, enclosed by walls of hydraulic masonry, will be built forty-eight by thirty-six feet in the clear, in the middle of which will be placed a forebay of massive timber and plank twenty-two feet square, within which will be a pump well of ten feet square.

The forebay will be so placed as to furnish water to four Turbines, each of which will drive a pair of plunger pumps, all of which will discharge into one common pumping main. With the full head of water, one of these Turbines and its two pumps, will furnish the present supply, by running twenty-four hours per day, and at times of the most back water the two wheels, which are now proposed to be erected, will furnish the supply, by running sixteen hours per day.

The maximum head of water, at the lower dam is ten feet, and at the upper dam is sixteen feet. This difference will be much lessened by the increase of back water at the upper dam, in times of freshets in the river, and therefore the

wheels arranged for the lower power are also estimated for the upper one, although they will give an excess of power in the latter case.

A wheel of fifty-four inches diameter is proposed, which, under twelve feet head, will move three times as fast as it is desirable to move the plunger of the pumps ; a small pinion will, therefore, be placed upon the water-wheel shaft, which will work into two spur wheels of three times its diameter. Into one of the arms of each of these spur wheels will be inserted a steel pin, to which will be attached a connecting rod, the other end of which will be connected with the pump plunger.

The pumps will be single acting, with a chamber of fourteen inches diameter, and a plunger of nine inches diameter and three feet length of stroke.

Each pump will have an independent suction pipe of ten inches diameter, extending ten feet deep into the pump well, with a rose piece strain and check valve at the bottom, and another valve at the top and a third delivery valve, in a short pipe, connecting with the pump main.

The second wheel will be placed on the opposite side of the forebay, and with its pair of pumps arranged in the same manner and communicating with the same pump main.

On a pipe, central to all four of the pumps, will be placed a large air chamber and a waste pipe with a stop cock.

At the lower dam location, there will be an independent pump main, of ten inches diameter, to the Reservoir on each side of the river, with check valves, air chambers and stop cocks in each; and from the upper dam, the pump main will be common to the corner of Talman and Murray streets, and then branch off to each of the Reservoirs.

At the lower dam location the pump main to the West Division Reservoir will be carried over the hydraulic canal on a bridge, and will be boxed and filled with charcoal. The main to the East Division Reservoir will be laid across the bed of the river, below the dam, in a trench excavated in the rock and, after the pipe is laid, it will be covered with hy-

draulic masonry. A stop cock will be placed on each side of the river. This main will also be carried over the hydraulic and State canals by a bridge or under them in trenches.

The wheels and pumps at the upper dam location may be placed on either the East or West side of the river, and two favorable sites for Reservoirs exist on each side of the river, viz: on the East side on Carrington Hill, or near the Lawrence Park; and on the West side on Reservoir Square, or near the Asylum.

As these several sites present nearly equal advantages, it is not necessary to indicate the preferable ones more particularly, until arrangements have been made to secure the land for the Reservoirs.

The course of the pump mains will be governed by the location of the power and of the Reservoir.

A submerged pump main can be carried across the river, between the two dams, or it may be carried across Utica street Bridge as in the Lake plan.

The plan of the Reservoirs and the system of Distribution will be substantially the same for all of the plans.

RESERVOIRS.

In a water supply, dependent upon mechanical power, it is desirable to have as large reservoir capacity as possible, to provide against an interruption from the derangement of any part of the machinery. This is also advantageous in case of protracted conflagrations, as it will keep up the head without the hazard of running the machinery too fast, which is very likely to occur in the excitement produced on such occasions. It is also desirable to make the Reservoir in two divisions, so that the water may be settling in one while the other is being filled. In the plans herein proposed, the two Reservoirs on the opposite sides of the river will answer the purpose of the two divisions at such times as the river water may require settling. These plans contemplate the storage of fifteen millions of gallons, with land to be purchased on which an additional division may be built hereafter, to double this

storage. The former would, if economically used, last a month and the latter two months of the ordinary consumption—which is deemed ample for the case in hand.

The following general description of the manner of building the Reservoirs proposed, will apply to all those spoken of. The enclosing banks will be of earth, finished off with sixteen feet width at the top and slopes of two horizontal to one vertical, and carried up to four feet above the surface of the water in front, and three feet in the rear, but the water may on occasions be raised one and a half feet higher. The excavation to be of such depth as to furnish the materials for the banks. The bottom of the Reservoir will be ploughed up very deep, the stones and pervious materials removed, and the remainder well puddled and covered with four inches depth of clean coarse sand or fine gravel. The side puddle walls will conform to the slope of the banks, and will be twelve feet wide at the bottom and six feet at the top and carried up to within one foot of the top of the bank. The inside of the banks will be faced with gravel one foot thick, upon which will be laid a slope wall also one foot thick. The rear slopes and top of the banks will be turfed. The grounds will be enclosed by a strong picket fence six feet high, with suitable gates. A waste pipe of iron, eight inches in diameter, will be laid through the banks and extended to a proper waste place by a vitrified earthen-ware pipe of the same size. The inlet and outlet pipes shall be of iron, twelve inches in diameter, provided with stop cocks, which will be placed in a stone vault covered by a small brick house. The pump main will be connected with the distribution main, so as to supply the latter directly from the pumps, without passing into the Reservoir. These pipes will be extended into the Reservoir at least ten feet beyond the foot of the banks, and will be enclosed in a box of wood with screens and strainers on the outlet pipe. A drive way may be made on the top of the Reservoir banks, and the grounds may be ornamented with flowers and shrubbery. The cost of the second division of the Reservoir will be about two-thirds of the cost of the first.

DISTRIBUTION.

The pipes will be laid of the several sizes and in the streets named in the annexed schedule. The trenches will be dug to such a depth as that all of the pipes will be covered with at least four feet of earth, and on grades arranged so that every part of the pipes can be drained and with no crowning places. The earth under and around the pipes will be selected of the best material and rammed in firmly, and the remainder of the trench will be filled up evenly and solidly. There will be six water districts, separated by lines of stop cocks, so that the water can be drawn off from either district without interrupting the supply to the others. Fire hydrants will be placed at every alternate corner and at every dead end of pipe, and each one will be connected with the street main by pipes of four inches diameter. There will be two six inch mains running North and South in each Division of the City, and three East and West mains of the same size. The other pipes, except the pump mains and a few short ones of three inches diameter, will all be of four inches in diameter —amounting in all to sixteen and a half inches. A main of ten inches in diameter will extend from each Reservoir in Seventh street to Utica street, and will be connected through Utica street, passing over the river with a stop cock on each side. Each Grand Division of the City will thus have its Reservoir and distribution independent of the other, but arranged so that each one may be supplied from the Reservoir of the other.

THE QUANTITY OF WATER TO BE SUPPLIED.

The actual consumption of water for domestic uses would be liberally supplied, by allowing twenty gallons per day for each inhabitant. The experience of other American cities shows that there is as much wasted as used, and to allow for this waste and also for the use of various mechanical and other works, it is now customary to provide a quantity equal to sixty gallons per day for each person.

The population of Oswego is about twenty thousand, and

in the plans herein submitted, it is proposed to furnish a daily supply of one and a half millions of gallons, which is equal to seventy-five gallons for each inhabitant, and to provide for an increase of this supply to two and a quarter millions of gallons daily, without any alteration of the works, but simply by running the pumps twenty-four instead of sixteen hours, and then by duplicating the wheels and pumps, and without other expense, to double the last mentioned quantity. This arrangement seems to be ample to meet the probable future increase of population and business for many years, and it has the advantage that no portion of the present expenditure will be lost until the demand for water exceeds three times the present supply.

Upon the Lake plan the pumping mains are almost necessarily connected with and used for the distribution, and this will bring upon the most of the street and house service pipes an increased head, and will also subject them to shocks from the operations of the pumps and sometimes of the recoil of the water through such long mains. A stand pipe at the pump house would materially lessen the last of these evils, but it would be so costly that I have not added it to the estimate for that plan. In all the plans it has been arranged to pump directly into the distribution mains when the Reservoirs are out of order or when an unusual quantity of water is required, under great head, during conflagrations.

Annexed will be found a table showing the head of the water in the street pipes, above the level of the Lake, at the prominent places in the City, both when the supply is derived from the Reservoir and when the pumping and distributing mains are connected. In the latter case, however, this head may be increased up to the capacity of the power and the strength of the pipes, and to prevent subjecting the machinery and pipes to too great a strain, a safety valve will be put on the air chamber of the pumps. This table would be more interesting if the head of water above the level of the streets

were given, but the City Surveyor can furnish you with such a table from the data herein given.

THE QUALITY OF THE WATER.

In the mixed population of a city, there are always prejudices and fallacies in regard to this branch of the subject, which it is advisable to remove by a statement of the received opinions of the source of water and the changes which it undergoes before it is used. Water, in its three-fold condition of vapor, liquid and solid, performs some of the most important functions in the natural and artificial purposes of life. In the first, invisibly associated with the air, it nourishes vegetation ; in the second, it forms one of the components of almost every substance in nature, and in the third condition it protects vegetation and prevents the injurious effects of the low temperature which gives to it a solid form.

The parent source of all of the fresh water on the earth, is the Ocean; and the atmosphere is the vehicle by which it is conveyed over and precipitated upon the land, from whence after performing its various functions, it flows back to the sea, to be again exhaled and distributed over the land, and has thus incessantly circulated for ages.

The temperature of the air determines how much watery vapor it will contain. With an increase it will absorb more, and with a diminution of temperature the excess is thrown off. This process of absorption and precipitation is in constant action, and produce the palpable changes of drought and moisture, besides a vast imperceptable action of the same kind in the growth, ripening and decay of vegetation and animal life.

The winds apparently so capricious, are governed by natural laws. The increasing temperature and velocity of rotation from the poles towards the equator, give the first great direction to the winds. These great currents encountering the elevated ranges of land, are deflected and produce eddies and irregularities near the surface of the earth, but there will in all places be found a general direction to the winds. The

warm atmosphere from towards the South, moving over the face of the Ocean, absorbs its moisture until fully saturated, and then blown over the land and driven upward into contact with cooler strata of air or of the earth, it yields its excess of moisture in dew, rain or snow, and passing onward is again warmed and renews its absorption of watery vapor, to be again discharged on the land.

The water which is thus precipitated upon the earth, is absorbed by growing vegetation or flows off through the superficial water courses to the brooks and rivers and back to the ocean, or it penetrates the porous soil in drops which unite together beneath the surface in threads, veins and strata, and descending until they meet some impenetrable stratum over which they flow subterraneously and re-appear in seeping places, springs, and sometimes in streams of considerable size. Springs derive their supply from these rain drops, which have penetrated the porous soil, and wells are merely the interception of these underground threads and veins of water, while ponds and lakes are formed in depressed places by the same drops, over a substratum of soil or rock, through which they cannot percolate, and the water rises to the brim of the natural water-tight basin and flows over in a brook or river.

Water is never found in nature in a perfectly pure condition. In its vapory form, it has a strong affinity for the other gaseous substances with which the air is charged from effete matter. And in its liquid form it is a solvent of many substances which it is brought into contact with, upon and beneath the earth. Water is most pure when it is first evaporated in mid ocean, but as the vapory winds are driven over the land, as before stated, it absorbs deleterious gases, and when it flows over or beneath the surface of the earth, it takes up in solution decaying vegetable and animal matter and the earthy salts and other injurious soluble substances. Rain water, flowing through a pure atmosphere upon a clean surface, is the purest form in which it can be found. That which falls upon a pure sandy soil, free from vegetation, is

the next purest. Vegetation and animal life, while growing, are absorbents of deleterious matter in the air and water, but in decay give out that which is noxious to both. Surface water is, therefore, the least pure in the autumn and the most so in the winter and spring—while spring and well waters, which derive their impurities from earthy solutions, are equally impure at all seasons of the year.

The foregoing description of the natural operations to which water is subjected, is necessary to enable us to determine which is best for the purposes under consideration. For drinking, water should be wholesome, clear, cool and ærated, and for other domestic and manufacturing purposes, it must be soft and limpid. For a public water supply, therefore, the water should be selected having the following characteristics in the highest degree possible, viz : first, purity ; next, softness; and next, limpidity. If all of the rain water which falls in a city was stored, it would furnish a supply sufficient in quantity for domestic uses, but it would be very objectionable in quality. The atmosphere over a city is always charged with the gaseous products of combustion and those arising from decaying animal and vegetable matter, garbage and sewage matter. The roofs are covered with these substances condensed from the gases, and with soot, dust from fœcal matter in the streets, and decaying woody matter on shingled roofs, and metalic oxides on metalic roofs. The rain water absorbs all of these, and stored in close cisterns loses its æration and becomes insipid and unless cooled with ice, is repugnant to the taste. That such water is very impure, is evident by the rapid production of animalculæ in it, which show the presence of the food necessary to maintain that minute but vast quantity of animal life. It is supposed that filtration will remove the impurities of water, but those in ordinary use only remove such matter as is suspended in and none of that which is chemically united with the water, and chemical filters to separate the latter are expensive and must be changed with the constantly changing condition of the water.

Spring water is rarely found in abundance in a city, and is

usually the least pure of the waters of the neighborhood. The temperature of water from deep seated springs is that of the earth at such depth, which is about the mean temperature of the place for the year. At the point of issue, the temperature of spring water changes a little with that of the season, so that deep seated springs at Oswego would have a temperature of about 45° in winter and 55° in summer. Spring water is usually highly charged with air, and this, with its low temperature in summer and high in winter, compared with that of air, renders it so grateful. The earthy salts in such water, frequently renders it more pleasant to the taste, but it is not always healthful.

Water from wells in cities is always unfit for drinking—and in most cases is very deleterious to health. Investigations have been made all over the country, which show that some of the most serious diseases arise from the use of well water in cities. In times of cholera, the progress and fatality of this disease has been traced, in a vast number of cases, directly to the use of impure water from certain wells ; and their analyses, compared with that of other wells in the same cities, show that this frightful disease is promoted and rendered more fatal by the use of well water.

Annexed will be found a table showing the character of the well water, which, at one time, had been used in several cities, and fully bear out the assertion that well water in cities is not fit for drinking. From what has been said before, it will be seen that well water becomes charged with all of the dissolving gases in the atmosphere and on the surface as well as the solutions of decayed matter, and mingled with the drainage of stables and privies which have entered the soil, combine to render such water a most disgusting solution. The water of rapid brooks and rivers become highly charged with air, but their currents abrade the banks and bottom and take up in suspension the alluvial matter, which renders them turbid and in that condition unfit for domestic uses. When such water is discharged into a lake or artificial reservoir and allowed to stand quiet, it precipitates all of the heavy portions

of such suspended matter and becomes clear and limpid. These rapid streams also gather and carry forward with them a considerable amount of vegetable matter, which is of the same or less specific gravity as the water. A warm atmosphere dissolves the latter into gases, which arise and are driven off, and a process of self-purification goes on which greatly improves the water.

Water which has been stored for use in some of our cities, has sometimes been defiled for a few days, during the warmest weather, by the rapid production of animalculæ or aquatic vegetation, the seeds of which lie dormant within the body of the water and are generated when the water has remained stagnant at a high temperature for some time, and probably when the atmosphere is in a certain electric condition. The conjunction of all of the causes necessary to generate this minute life, occur only at long intervals of years and then only exists for a few days, and the first fall in the temperature or the first brisk breeze destroys the conditions necessary to maintain this ephemeral life, and following a general law of nature, they die and dissolve into gases as quickly as they were generated, and in a few days the water is more pure than before. Water does not receive or part with caloric freely, and stored in large and deep bodies maintains an equal temperature at all seasons of the year. The fierce rays of the noon-day sun and currents of hot air, in contact with the large bodies of water proposed to be stored in the reservoirs, would be tempered by that of the cooler nights and less warmer days, so as to give to it a lower temperature in summer and higher in winter than that of the river from which it is drawn, and this water conveyed in pipes below the surface of the earth, will be delivered at the houses at a very equable temperature.

The Oswego River water is sometimes too turbid for domestic uses, and it has been suggested that it ought to be filtered before it is delivered into the distribution pipes. The quantity of water which is required for drinking, cooking and washing, will not be ten per cent. of the whole quantity

which is to be pumped, it would, therefore, be the cheapest plan to have a filter in each house. The storing of the water in the reservoirs and allowing it to remain quiet for a few days, will be the best plan of filtering, but if it is desired, the water might be run through a large filter for a specified hour each day, and each family can then draw off and store enough for a day's consumption. Such a filter could be made at a small expense, but I have not included it in the estimate.*

I have had no access to an analysis of the Oswego River water, and presume that none has been made, its quality can, therefore, only be arrived at by a consideration of the character of the soil of its water shed and of the tributaries of the river. It has, however, been stated to me that those who have used it for washing and mechanical purposes, consider it a soft water, and in that respect equal or superior to the lake water. The Oswego River drains nearly three thousand square miles, embracing seven of the larger interior lakes, which, with a good many smaller ones, have an aggregate area of three hundred square miles, and supply nine-tenths of the whole water of the river. The water sheds of these lakes and of their tributary streams are generally on gentle declivities over a well cultivated country. At the head of the lakes there are generally swamps of small extent, and along the Seneca River is a marsh of considerable size. Nine-tenths of the whole area is of the most desirable character to yield an unusually pure river water. A considerable portion is a lime-stone country, and corresponds with the drainage area of Lake Ontario and the chain of large lakes about it.

The analysis of the waters of the sources of the river would, therefore, probably show nearly the same components as the lake water. In the flow of these waters to and through the Oswego River, they again take up the alluvial matter of the bed and shores which render them turbid, and are mingled

---

*NOTE.—There are in constant use at Kingsford's Starch Factory, filters which the proprietors say purify a million of gallons of water daily. The water thus purified is beautifully clear and superior, in that respect, to the clearest lake water These filters are made of clean, lake washed gravel and sand, and merely remove from the river water its *suspended* matter. They do not change its chemical constituents. The subsidence from the river water by the proposed reservoirs, will accomplish the same results to a degree, though not as completely as such filtering.

with the highly colored waters from the Montezuma Marshes, and are also charged with vegetable matter, both in solution and suspension. This coloring and alluvial matter is so observable as to produce the strong prejudice which has existed against the use of the river water. As before stated, the storing reservoir proposed, will remove the alluvial matter which is held in suspension, and the coloring is innocuous and of so faint a tinge as to be of little account.*

The marshes spoken of have an area of less than one per ct. of the whole water shed of the river.† The aquatic vegetation in them does not give to its waters much decaying matter, and though they and other swamps along the tributaries undoubtedly deteriorate the pure waters issuing fromthe lakes, yet it is to a less extent than would at first be supposed. The samples of river and lake water which were taken up in August last, exhibit about the same amount of floculent vegetable matter suspended in each. Late in the autumn the river water would show a larger amount than the lake water.

The waters of the St. Lawrence and each of the great lakes which it drains, have been repeatedly analyzed and show nearly the same constituents in each. Professor Douglas made an exceedingly minute analysis of the Detroit River water in 1854, which reduced to the American measures used for this purpose, is as follows :

TABLE OF THE NUMBER OF GRAINS IN ONE GALLON.

Silica,	0.28	grains.
Oxide of Iron,	0.28	"
Lime,	1.93	"
Potassium,	0.07	"
Sodium,	0.14	"
Sulphuric acid,	0.29	"
Phosphoric acid,	0.78	"
Carbonic acid,	0.96	"
Allumina,	0.58	"
Total,	5.32	"

*NOTE.—The United States ships-of-war for half a century have been supplied with water for long voyages, from the Elizabeth River, at Norfolk, which drains the Dismal Swamp, and is as highly colored as pale brandy. This water in the Navy, is prefered to any other, and is found to be perfectly healthy. I have drank some of it. which had been kept in the tanks of the store-ship for twenty-five years, and found it perfectly pure and limpid. Its coloring had all faded out.

†Professor Hall says they cover sixty thousand acres.

Professor Mather analyzed the waters of Lake Erie, off Cleveland Harbor, in 1852, from two places, one near the shore and the other half a mile out, as follows :

	NEAR THE SHORE.		HALF A MILE OUT.	
Solid matter in a gallon,	8.33	grains.	2.54	grains.
Lost by ignition,	3.49	"	0.80	"
Organic matter,	0.24	"	0.20	"
Earthy and saline matter,	4.84	"	1.74	"

And he remarks : "The two lake waters contain a little car-"bonate, sulphate and muriate of lime, magnesia and oxide "of iron. These two samples of water show the extremes of "relative purity of the waters that may be expected to be "raised by the water works (at Cleveland) at the different "seasons of the year."

The water of Lake Ontario* at the mouth of the Genesee River half a mile out from the piers, is said to have been analyzed and found to contain eleven grains of solid matter in a gallon the day after a storm; and at a thousand feet from the shore, on the same day, four grains. The seasons of the year and the direction of the wind when these waters were taken up for analyzation, are not stated. The result given by Professor Mather may be taken for the purity of the water of Lake Ontario in its most favorable season and beyond the influence of the shore, and that given by Professor Douglas as the most favorable condition of such water as would be obtained by the lake plan at Oswego, and these may also be taken for the condition of the water from the smaller lakes which form the sources of the Oswego River, when discharged at their several outlets. A careful consideration of the whole subject leads me to the conclusion that, with the operation of the large reservoirs proposed, the City of Oswego may be supplied with water from the Oswego River which, for all uses,

*NOTE. The bed of Lake Ontario is several hundred feet below the level of the sea, and Doctor Beck says : "An opinion was at one time entertained that the water of Lake Ontario "was salt at the bottom, but recent and carefully conducted experiments have proved that "such is not the case. It is found like that of most of our inland lakes and rivers, to be "nearly pure, containing only minute quantities of the carbonate and sulphate of lime and "the cloride of calcium."—*Nat. History of New York, Art. Mineralogy, p.* 180.

will be equal to that which could, at a reasonable expense, be procured from the lake.

ESTIMATES OF THE COST.

These estimates do not include the cost of the land for the pumping houses, or the reservoirs, or the right of way for the pipes, or for the use of the water. The former will be about the same on each of the plans, and may be set down at from ten to twenty thousand dollars. The cost of running the condensing steam engine per year, would be as follows:

Wages of an engineer and fireman,	$ 2,000
Oil, tallow, waste and repairs, $5 per day,	1,825
	$ 3,825
Cost of coal for engine of 143-horse power, 1,800 tons, $10 per ton,	18,000
Total,	$21,825
Or for an engine of 123-horse power, 1,500 tons, $10 per ton, $1,500	$18,825

The cost of running the water-wheels and pumps per year, will be:

Wages of a mechanic and laborer,	$ 1,500
Oil, tallow, waste, repairs and heating wheel-pit,	1,100
	$ 2,600
For the use of water-power at lower dam, 9 run of stone, $500,	4,500
Total,	$ 7,100
Or at upper dam, 13 run of stone, $200—$2,600	$ 5,200

The capital, the interest of which would pay the above annual expenses, is as follows:

Lake plan, foot of Eighth street,	$268,923
do at Sheldon's Point,	311,786
River plan, lower dam,	101,428
do upper dam,	74,286

1. THE COST OF THE LAKE PLAN—PUMPS AT FOOT OF EIGHTH STREET.

A pipe of wrought iron, four feet in diameter, from the pump well, extended six hundred feet into the lake,	$ 17,300
A protecting pier of timber, well bolted and filled with stone, and an inlet well with gates and screens,	37,000
A pump well excavated in the rock and a foundation wall on top, for the engines and pumps—including the gates, screens and partition,	5,500
An engine, boiler and coal house, and chimney of brick,	13,041
A condensing steam engine of 123-horse power, and pumps, also a non-condensing engine of 80-horse power and pumps,	53,455
A pump main of twelve inches diameter to the corner of Utica and Eighth street, and thence, of ten inches, to each reservoir, with the stop cocks, check valves, air chamber, and boxing across the river,	49,450
Two reservoirs, each to contain five millions of gallons, with inlet and outlet pipes, drain, pipe vault and fence,	49,670
The distribution pipes (fifteen miles) with stop cocks and hydrants,	104,670
	$330,086
If wrought iron pipes, lined and covered with hydraulic cement, are substituted for cast iron pipes, where it can be safely done, it will reduce this estimate,	30,000
Total,	$300,086

If the pumps are placed at Sheldon's Point, and the reservoirs are increased to hold seven and a half million gal-

lons, and the street pipes are increased to sixteen and a half miles, it will add as follows:

For the engines and pump main,	$17,050	
do reservoirs,	10,000	
do extra street pipes,	10,500	
		$ 37,550
Total,		$337,636

2. THE RIVER PLAN—FROM THE LOWER DAM.

A wheel-house of brick and wheel-pit of stone,	$ 9,250
A forebay and connections with the canal,	3,000
Two water wheels, pumps and gearing,	12,500
A forcing main of ten inches diameter to each reservoir, with stop cocks, check valves, air chamber, bridges and pipe boxing over hydraulic and State canals, trenching and laying pump main across the bed of the river,	30,800
Two reservoirs, (five million gallons,) same as in Lake plan,	49,670
The distribution pipes, (fifteen miles,) cocks and hydrants, boxing pipes at Utica street bridge,	124,820
	$230,040
If iron and cement pipes are substituted, it will reduce,	30,000
Total,	$200,040
If the reservoirs are increased to hold seven and a half million gallons, and the street pipes to sixteen and a half miles, it will add,	20,500
Total,	$220,540

3. THE RIVER PLAN—FROM THE UPPER DAM.

A wheel-house, forebay, wheels and pumps, nearly as above,	$ 22,750
A forcing main to each reservoir, and fixtures,	50,000
Two reservoirs, etc., nearly as above,	46,670

The distribution as above,	124,820
	$244,240
If cement pipes are used, it will reduce the estimate,	30,500
Total,	$213,740
If the reservoirs and street pipes are increased as above, it will add,	20,500
Total,	$233,740

RECAPITULATION.

The Lake plan,	from foot of 8th St.,	$300.086	Add 10 per ct,	$330,094
do	do Sheldon's Point,	337,636	do	371,400
The River plan,	from the lower dam,	200,040	do	220,044
do	do enlarged res'rs, etc.	220,540	do	242,594
do	do the upper dam,	214,240	do	235,664
do	do enlarged res'rs, etc.	233,740	do	258,214

COMPARISON OF THE PLANS.

The excessive cost of the Lake plans, as well as the annual expense of running the engines and the hazard of maintaining the piers in the lake, are not balanced by any fancied superiority in the quality of the water, and leaves the question to a choice between the two River plans. The increased cost of the rental of the water power, from the lower dam, represents a capital which, at first, is nearly equal to the difference in the cost of the two plans. For the water works, it is indispensible that a preference right to the use of the water should be acquired. All of the first class water powers from the lower dam are understood to have been sold, and therefore it would be necessary to purchase some of the powers already occupied. The power necessary to elevate the quantity of water required for the present supply, is equal to that usually furnished to drive four and a half run of stone, and eventually twice as much will probably be required.*

*NOTE.—The contracts of the Hydraulic Canal Company at Oswego formerly provided eleven and three-quarter cubic feet per second, under sixteen feet head, for a run of stone. The recent contracts provide twenty cubic feet, which gives a theoretic horse power of 36.[illegible]. The water wheels in general use at that place, after allowing for waste, yield an effective power of fifty-five per cent. of the theoretic weight of the water, which gives an effective horse power of twenty for this quantity and fall of water. The whole water of the Oswego River at ordinary low water is equal to 3781 theoretic horse power, fifty-five per cent of which is 2[illegible]79 horse power, or equal to one hundred run of stone. One guage of the river, in an extraordinary low time, gave but three-fifths of the above stated amount of water.

The abstraction of a million and a half of gallons daily, (two and a third cubic feet per second,) for consumption in the city, is of little importance, as a considerable portion of it would be returned again to the hydraulic canals, but the absorption of so large a portion of the power from the lower dam would be prejudicial to the interests of the city, and it is probable that a large majority of the citizens would prefer to encounter the small increase of the first cost of the water works, by taking the power from the upper dam.

One of the important elements of the prosperity of Oswego is this lower water power, placed where vessels with grain from the upper lakes and Canada, can be unloaded by elevators directly into the mills, where it is to be ground and the manufactured article loaded into canal boats. The advantages of this handling by mechanical power, and the cheapness of the condensation of the value of these ponderous articles before transhipment to the more expensive conveyance by canal although now demonstrated, will only be fully realized when the price of the cereal products are again reduced to their normal lower standard.

Throughout all of the immense grain producing regions of the West, there is almost no water power—and steam power is too expensive to be generally introduced for milling purposes. The great expense of land transport to the Railroads and the high cost of carriage upon them, compared with the extraordinary cheapness of this description of lake transportation, will compel these heavy products to take the latter and then the canals to market, whenever the price is low, and at such times the advantages which Oswego presents for handling and condensing their weight and shortening the canal navigation, will bring into demand the entire water power of the lower hydraulic canals at Oswego. For these reasons it would be injudicious to locate the works in question at the lower dam.

RESUME.

The preceding discursive arguments may be more summarily stated, as follows:

An abundant supply of pure and wholesome water is necessary for the health, comfort and prosperity of a city, and a public work furnishes it of better quality at less cost and with greater convenience, than it can be obtained by individual efforts. All of the water procurable within a city, by wells and cisterns, is impure and unfit for potation. The cost of wells and cisterns, reservoirs and pumps, at each house and the labor expended in raising the water from them, is, in the aggregate greater than the cost and maintainance of an equal public supply, while the ready accessibility and ample quantity at hand at all times of a well arranged public supply is a preventive against, or a diminution of, the damage from fires, equal, in the long run, to the cost of the works, while an abundant use of water by the poor, as well as the rich, lessens disease, and its effect in increasing settlements and investments amply repay, even in a financial view, the expenditure.

A well arranged plan of a public water supply, however much opposed *before* construction, is always sure to prevail and *afterwards* secures universal approbation. The City of Oswego presents unusual facilities for procuring a bountiful supply of pure and wholesome water, at a small outlay, compared with other cities, of greater and less size, which have been supplied.

A previous examination of the question limits the supply to two sources, viz: from Lake Ontario and from the Oswego River, both of which require the use of mechanical power to elevate the water into reservoirs, from which it will be distributed, by iron or cement lined pipes, to all parts of the city. The former requires the use of steam, and for the latter the water power already created on the river, will be used.

The Lake plan requires a costly arrangement to obtain the water, free from the impurities along the shore and from the river; and the River plans contemplate a purification, by large settling reservoirs, and both plans are provided with a duplication of the machinery, reservoirs and distribution, to meet accidental interruptions and maintain an ample supply at all

times, and both plans are also arranged for an enlargement (without loss of any previous expenditure) for treble the present population.

The river water in flowing through the city, becomes contaminated with sewage, garbage, and the refuse matter from manufactories and vessels, which the winds drive along shore after they enter the lake. And though these winds prevail from the West, yet they blow from the East for one-fourth of the time, and render it necessary to obtain the supply from the furthest practicable western point.

Large reservoirs as near the centre of consumption as possible are necessary to all well arranged water works, and particularly where they are dependent upon mechanical power. Such reservoirs become invaluable in protracted conflagrations, in maintaining the head and furnishing an ample supply. The reservoirs proposed will contain fifteen millions of gallons and are arranged for an enlargement to hold double this quantity. The former, if economically used, will last a month of ordinary consumption. The use of two reservoirs, on the opposite sides of the river, with the arrangement of the mains and street pipes, will permit the water to stand and settle in one while it is being used from the other, and thus purify before distributing it for use, and when the second division is added to the reservoirs it will allow the water to settle and purify for a month or six weeks before it is used.

The distributing pipes will be arranged with large feeding mains and intermediate pipes of smaller size, in most cases, however, not less than four inches diameter. The city will be divided into six water districts, from each of which the water may be shut off without interrupting the supply to the others.

Six fire hydrants are proposed for each mile of pipe, and they will be placed at every alternate corner, so that in case of fire, at least four hydrants will be accessible, with hose of the length of one block The plans are arranged to furnish an unusual large supply of water, viz: seventy-five gallons to each person, and this may be increased one-half, by the ex-

pense of the services of one more attendant; and then again doubled by duplicating the pumping machinery. (In the River plans at an outlay of ten or twelve thousand dollars.)

All of the plans provide for pumping directly into the distributing pipes if it should ever be necessary to give more head or water during conflagrations, or when from any cause the water in either reservoir is not available. In such cases the head of water in the street pipes may be increased up to the power and strength of the pumping machinery and pipes.

To meet the usual objections, prejudices, and fallacies, in regard to the sources of water and the changes which it undergoes, a disertation of some length on this branch of the subject has been indulged in, and an application of the received laws to the several natural waters, accessible to the city, has been made. These show that all of the water descends from the clouds in nearly a pure state, and receives its contaminations from the gases of the atmosphere, the dissolving substances on the surface of the earth, and the soluble salts of the soil below the surface.

Rain water, though elsewhere comparatively pure, is seriously contaminated when collected in a city, and is not an agreable but sometimes an unwholesome beverage. Well water is the most impure of any of the natural waters, and in cities is totally unfit for drinking, as it contains the solutions of sewage from privies and stables, from decaying garbage, from the soil long saturated with the above solutions, and from an impure atmosphere above and earthy salts below. Examples without number might be given to show that disease and death can be traced directly to the use of such water, in particular cases and by analogy, that they are always detrimental to health.

Usually brook and river water is chemically the most pure, though they contain earthy and vegetable matter in suspension, and at times to such an extent as to render them unfit for domestic uses. Natural lakes, receiving such water, cause the heavier portions of the suspended matter to be precipitated and the lighter, floating on the surface, are decomposed

and exhale, leaving the water [in its most pure natural condition. Artificial reservoirs, such as those proposed for the Oswego water works, will perform the same service as the natural lakes in the purification of the water which is placed in them, and their depth and volume will keep such water at a more equable temperature—cooler in summer and warmer in winter, than the river water in its natural channel.

If the lake water could be procured from a considerable distance out in the lake, at a reasonable expense, it would furnish it at all times of a quality superior, for all purposes, to the river water, although it is said that the latter is the softest. As the case will not warrant the large expenditure necessary to procure lake water a mile from the shore, the comparison must be made with that which can be obtained within a reasonable distance, and where it will be more or less contaminated by the river and shore. The analyses of the waters from all the large lakes, show them to be very pure away from these influences, but near them to be not superior to the river waters when not disturbed by floods. The water shed of the Oswego River is such as to afford a good quality of river water, and the numerous lakes forming its sources are self-purifiers, while the short water courses to the main river are not likely to contaminate these pure lake waters more than will be removed by the subsidence in the reservoirs. The waters of the Oswego River thus purified, will, for all purposes of the city, be equal to such lake water as can be procured at a reasonable expense, and the cost of construction and maintainance of the works from the former being so much less than the latter, compel me to recommend the selection of one of the River plans.

The present and future occupation of the whole of the water power, from the lower dam, for milling and elevating purposes, is so essential to the commercial interests of Oswego, that it is believed a majority of the citizens would prefer to incur the small extra expense of the water works at the upper dam, rather than to abstract the power necessary from the lower dam.

In view of the preceding arguments, I would recommend for adoption River Plan No. 3, locating the pumping works on the East or the West end of the upper dam, as may be found most advantageous, and with two reservoirs as proposed, near Carrington Hill or Lawrence Park on the one side, and near Reservoir Square or the Asylum on the other side of the river—where the land can be obtained on the best terms.

Respectfully submitted.

WM. J. McALPINE.

P. S.—I have prepared the foregoing estimates from detailed drawings of all of the parts of the several plans. Whenever the project is adopted, I will copy these plans for working drawings, and can also furnish specifications, so that the work may be executed by any Engineer whom you may then select.

TABLE*

Of the length and sizes of the pipes proposed to be laid in in the Streets on the Lake plan:

IN STREET.	FROM.	TO.	LENGTH OF EACH SIZE. 10 IN.	8 IN.	6 IN.	4 IN.	3 IN.
Talman,	Murray	Reservoir	Main.				
Varick,	do	3d					900
Niagara,		8th	Main.		1,900		
Utica,	7th, East	8th, West	do	900	300		
Mohawk,	9th to 4th, E.	6th to 9th, W				1,200	1,200
Oneida,	4th	2d, East					600
Bridge,	10th, East	12th, West		3,600	2,700		
Cayuga,	3d	4th, West					600
Seneca,	1st	12th, do				900	2,400
Schuyler,	9th	1st, East			2,400		
Van Buren,	5th	8th, West				900	
Bronson,	6th	8th, do					600
~~East Tenth,~~	~~Mitchell~~	~~Mohawk~~			~~3,500~~		
Ninth, Eighth and Third, East,	Schuyler	Bridge					4,500
Seventh, East	do	Lawrence			3,000	1,000	
Sixth, do	do	Mohawk				2,500	
Fifth, do	do	Lawrence				4,000	
Fourth, do	do	Utica	1,500		1,500		
Third, do	Oneida	Cochrane				2,800	
Second, do	Schuyler	do			1,500	1,800	1,500
First, do	do	Albany, half			1,500		500
First, West	Lake	Varick			4,500	800	900
Second, do	Van Buren	Niagara				5,000	
Third, do	Lake	Albany				3,500	800
Fourth, do	do	Niagara	1,500		3,000		1,000
Fifth, do	do	do				5,000	600
Sixth, do	Seneca	do				4,000	300
Seventh, do	do	do	Main.		2,500		
Eighth, do	do	Bridge	do			1,000	
Lawrence, East,	5th	7th, East					600
Total feet, 87,200 ; miles, 16½.			3,000	4,500	28,300	34,400	17,000
					3500		
					24800		

TABLE

Of the elevations in feet, or the head of water above the level of the lake, in the street pipes, at the intersection of the following streets, showing the head when the pumps are in operation, and in the next column the head is derived from the reservoir when the pumps are not in operation—*upon the Lake plan.*

These calculations of head are based upon a draft or consumption of water at the rate of one and a half millions of gallons daily, distributed according to the population. If the

*NOTE.—The above was arranged for the Lake plan and would be modified for the two River plans.

consumption of any particular district is more or less than this amount, the head will be universally less or more in proportion.

TABLE.*

THE LAKE PLANS.	NIAGARA, FROM		UTICA, FROM		BRIDGE, FROM		SCHUYLER, FROM	
	Pumps.	Res'rs.	Pumps.	Res'rs.	Pumps.	Res'rs.	Pumps.	Res'rs.
First Street, West Side, ----	180	176	180	178	203	176	215	175
Fourth do do ----	182	177	185	178	203	176	216	176
Eighth do do ----	184	179	192	178	204	177	216	177
First do East Side, ----	---	---	176	145	175	144	174	143
Fourth do do ----	171	148	172	149	168	145	167	144
Seventh do do ----	160	160	167	154	164	151	161	148

Upon the River Plans the pumps will generally be run to give 180 feet head above the lake at the Asylum Hill, and this will give, to all parts of the West division, the same head as is stated in the above table, as derived from the reservoir, and to all parts of the East division an elevation, while the pumps are working, of just twenty feet higher than the above table shows, as derived from the reservoirs. When the pumps are not running, and the head is derived from the reservoirs, and the cock in the connecting pipe between the two city divisions is shut, the head in both divisions will be the same as given in the above table as derived from the reservoirs.

*Note.—If, from the figures given in this table, are deducted the level of the respective intersections of the streets, above the lake, it will show the head of water in the pipes above the streets, as by the following table furnished by John McNair, City Surveyor :

	NIAGARA.		UTICA.		BRIDGE.		SCHUYLER.	
	Pumps.	Res'rs.	Pumps.	Res'rs.	Pumps.	Res'rs.	Pumps.	Res'rs.
First Street, West Side, ----	144	140	125	125	182	155	204	164
Fourth do do ----	111	106	130	123	151	124	183	143
Eighth do do ----	62	57	129	115	132	105	134	95
First do East Side, ----	---	---	114	83	144	113	170	139
Fourth do do ----	---	---	66	43	120	97	118	95
Seventh do do ----	---	---	27	14	130	117	117	104

TABLE

Of the comparative impurity of water furnished by a public supply and that obtained from wells in cities, reduced to the number of grains of solid matter contained in one gallon.

CITY.	FROM WELLS.	PUBLIC SUPPLY.	ANALYST.
London,	Lambeth, ...110 grs	Thames, ...20 to 28 grs	Brande.
do	St. Giles, ...105	Sea, ... 24	do
do	St. Paul's, ... 75	New River, ... 19	do
Manchester,	Several, (average,) 84	Rain Water, ... 3	Smith.
New York,	Manhattan, ...125	Croton, ...5 to 7	Chilton.
do	Several, (average,) 58	....	do
Brooklyn,	Smith street, ... 77	Long Is. Streams, 3	do
do	Several, (average,) 49	....	do
Albany,	Exchange, ... 65	Patroon's Creek, .. 5	Emmons.
do	Capitol, ... 65	Hudson River, ... 6	do
do	Old State House, .. 36	Mohawk, ... 8	do
Boston,	Beacon Hill, ... 50	Cochitnate, ... 2	Silliman.
do	Tremont, ... 26	....	
do	Long Acre, ... 57	....	
Hartford,	Average, ... 70	....	Silliman.
Philadelphia,	....	Schuylkill, ... 4	do
Washington,	Average, ... 16	Potomac, ... 6	Torrey.
Rochester,	Several, ...26 to 41	Lakes, ...1 to 4	Anonymous.
Cleveland,	do ......28 to 79	Cuyahoga River, .. 6	Mather.
Detroit,	Park, ...116*	Detroit River, ... 6	Douglas.
Cincinnati,	Brewery Spring, .. 35†	Ohio River, ... 7	Locke.

Professor Palmer, of Cleveland, says: "Cholera was more "fatal in that city in those districts where well water was "used, although the most high and apparently the most "healthy. The lower districts, containing such quantities of "surface water and filth as entirely to preclude the use of "well water, were supplied with water from the lake by carts, "and were comparatively free from this disease."

Professor Douglas says: "I am fully of the opinion that "the fearful ravages of cholera in that city (Sandusky) may "be, in a great measure, attributed to the use of impure wa- "ter, (from wells). * * * A careful examination would "probably show that, during the prevalence of cholera (in "Detroit) that disease was more fatal and prevailed to a "greater extent among those using the water of wells, than "among those in the habitual use of the river water. * * "Wells dug in large towns may be considered the most im-

*NOTE.—Doctor Terry says that the use of the water from this well in 1850, caused the death of seven persons, and the serious sickness of several more, and that no sickness ensued in the neighborhood after they changed to the use of river water.

† "This spring," says Prof. Locke, "produced fatal cholera in all persons who used it du- "ring the prevalence of the epidemic in the city. * * * It is admirably adapted to act "as the aid of epidemic in its hostility to human life."

"pure water in use. * * * Rain water, as ordinarily se-"cured, is far more deleterious than any water in use. I do "not hesitate to say that rain water, collected in the ordinary "mode, used as a habitual drink, must prove highly injurious "to health."

Professor Smith repeatedly analyzed the rain water which fell in Manchester, and frequently found it alkaline. It never gave less than 0.001 per cent. (half a grain to a gallon) of organic matter, and frequently 0.0027 per cent. of chlorine, and 0.0034 per cent. of sulphuric acid, (4.27 grains to the gallon).

Professor Hoffman, in his testimony before a Committee of Parliament, says that, "a thousand gallons of water, at the "the ordinary temperature, will dissolve as follows:

46	gallons of	oxygen;
25	do	nitrogen;
2,500	do	sulphuretted hydrogen;
1,000	do	carbonic acid;
500,000	do	ammonia."

Professor Clark, who has studied this subject more than any man in England, before the same Committee, says: "The "waters of lakes and rivers have a tendency to purify them-"selves spontaneously, by natural processes. * * * There "is a natural vegetating process, that goes on very readily, "freeing the water from vegetable matter, a spontaneous veg-"etation, and in its progress, a purification of the water takes "place universally. This process (in water in large masses,) "is probably that which also takes away the coloring matter "from water. Any process which throws down the solid "matter, sends down also the diffused dirty matter. So, like-"wise, in my process of precipitating chalk by lime-water, "what falls, is colored differently from the chalk; the coloring "matter has been carried down with the latter."